



# PATENT SPECIFICATION

Application Date : Jan. 27, 1944. No. 1581/44.

572,748

Complete Specification Left : Oct. 26, 1944.

Complete Specification Accepted : Oct. 22, 1945.

## PROVISIONAL SPECIFICATION

### Improvements in or relating to the Moulding of Plastics.

I, JOHN JOHNSON, a British Subject, of Plasta Works, Bath Road, Slough, Buckinghamshire, do hereby declare the nature of this invention to be as follows :—

5 This invention consists of improvements in or relating to the moulding of plastics and has particular reference to the moulding of optical elements such as lenses from transparent thermoplastic material although the invention is applicable to the moulding of other articles requiring great precision.

10 In British Specification No. 556,743 methods and apparatus are described for making optical elements particularly lenses from preformed blanks of transparent thermoplastic material such as methyl methacrylate or polystyrene. In such operations the demand for production has increased very rapidly and it has become necessary to make the operations much more automatic so that expert supervision is not required through all stages.

25 Broadly speaking in this invention the method of moulding plastics involves the use of two dies which are a sliding fit in a metal surround; a cold preformed blank is inserted between the dies which are brought gently into contact with the blank and thereafter the various stages of the operation namely heating of the blank to moulding temperature, application of moulding pressure, cooling of the dies and moulded article, release of pressure and opening of the mould are effected automatically by electric means. Details of operation such as the maintenance of pressure during cooling and the equalizing of the temperature of the two dies can be effected automatically.

40 According to this invention the inner face of each die contacts with the preformed blank and the outer face contacts with the inner face of a metallic plate (or shallow socket) which embodies an electric heating element; the outer face of this plate is normally spaced away from but can be brought into contact with a cooling block and the pressure on the relatively movable dies is applied through the said blocks. The current is switched on to the heating elements when the dies are

brought into contact with the blank and thereafter the switching off, the application and release of pressure are effected by thermostat control. 55

The nature of this invention and of subsidiary features thereof will be appreciated from the following description of a specific example reference being made to the accompanying drawings in which :— 60

Figure 1 is a sectional elevation of part of a mould for making a lens from a preformed blank of plastics; and 65

Figure 2 is an electric circuit diagram indicating the method of ensuring the thermostatic controls.

Referring to Figure 1, 12 is a preformed blank of a transparent plastic; 13 is the lower die and 14 is the upper die (both shewn with concave inner surfaces and flat outer surfaces); 15 is the lower heater here shewn as a shallow socket for the die 13, and 16 is the electric heating element for the heater 15. The top heater 17 is also shewn as a shallow socket for upper die 14 and it has an electric heating element 18. The surround 19 acts as a guide for the dies and it closely engages with the sides of the dies which in this case are circular in plan. The bottom cooling block 20 has upstanding guides 21 in the form of pins to enclose and guide the lower heater 15, the surround 19 (and the dies within). 22 are helical springs held in recesses in the bottom cooling block 20 and arranged to press on the under side of the heater 15 to keep it quite clearly spaced from the block 20 until the moulding pressure comes on. 70 75 80 85 90

The top cooling block 23 again has vertical guide pins 24 at intervals round the top heater 17 and in this case the pins 24 have inturned ends 25 on which the top heater 17 rests until the moulding pressure comes on. The operation is as follows :—The dies are carefully cleaned. 95

The cold preformed blank is carefully cleaned, laid on the lower die and the 100 upper die is lowered (by hand control) until the upper die just touches the blank, the dies being in close contact with their respective heaters but both heaters are spaced away from the cooling blocks. The position of the upper die may be controlled 105

by an electrical stop such that the operator is prevented from lowering the upper block too far. Current is turned on and the heaters, dies and blank all get heated. 5 When the dies and blanks have reached the required temperature for moulding, the current to the lower heater is automatically turned off by thermostat and the upper heater is kept at the same temperature as the lower heater by thermostat action. 10 At the same time the moulding pressure is automatically applied thus bringing the top cooling block down on to the top heater, bringing the lower heater into contact with the bottom cooling block and effecting the final moulding of the lens surfaces to their optically - accurate form. At this stage the two heaters 15 and 17 are simply acting as conductors of heat from the dies 13, 14 to the blocks 20 and 23 which if desired may have conduits 26 for cooling water.

Referring to Figure 2, 27 is a thermo-couple disposed in the lower heater 15 and arranged to control a potentiometer and switch 28 on the input side of a current transformer 29 the output 30 of which is

in circuit with the heating element 16. The current is cut off when the lower heater reaches a predetermined temperature. 30

31 and 32 are the two thermo-couples of a differential thermostat, 31 in heater 15 and 32 in heater 17. The differential thermostat is coupled to a potentiometer and switch 33 on the input side of a current transformer 34 the output of which is in circuit with the heating element 18 so that heater 17 is always kept at the same temperature as heater 15. 35 40

The drawings do not illustrate the electric relays which control the movements of the upper block 23 but these can be operated by the thermo-couple 27.

The top cooling block is resiliently mounted in known manner in the movable part of a hydraulic press so that during the cooling of the dies and plastic, the dies can "follow up" any shrinkage. 45

Dated this 27th day of January, 1944.

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## COMPLETE SPECIFICATION

### Improvements in or relating to the Moulding of Plastics.

50 I, JOHN JOHNSON, a British Subject, of Plasta Works, Bath Road, Slough, Buckinghamshire, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention consists of improvements in or relating to the moulding of plastics and has particular reference to the moulding of optical elements such as lenses from transparent thermoplastic material although the invention is applicable to the moulding of other articles requiring great precision.

65 In British Specification No. 556,743 methods and apparatus are described for making optical elements particularly lenses from preformed blanks of transparent thermoplastic material such as methyl methacrylate polymer or polystyrene. In such operations the demand for production has increased very rapidly and it has become necessary to make the operations much more automatic so that expert supervision is not required through all stages. 75

Broadly speaking in this invention the method of moulding plastics involves the use of two dies which are a sliding fit in a metal surround; a cold preformed blank is inserted between the dies which are

brought gently into contact with the blank and electric current is switched on; thereafter the various stages of the operation namely heating of the blank to moulding temperature, application of moulding pressure, cooling of the dies and moulded article, release of pressure and opening of the mould are effected automatically by electric means. Details of operation such as the maintenance of pressure during cooling and the equalizing of the temperature of the two dies can be effected automatically. 85 90

According to this invention the inner face of each die contacts with the preformed blank and the outer face contacts with the inner face of a metallic plate (or shallow socket) which embodies an electric heating element; the outer face of this plate is normally spaced away from but can be brought into contact with a cooling block and the pressure on the relatively movable dies is applied through the said blocks. The current is switched on to the heating elements when the dies are brought into contact with the blank and thereafter the switching off, the application and release of pressure are effected by thermostat control. 95 100 105 110

The nature of this invention and the manner in which it is performed will be appreciated from the following description

of a specific example, reference being made to the drawings accompanying the provisional specification (Figures 1 and 2) and to the accompanying drawings (Figs.

5 3, 4, 5, 6 and 7) in which:—

Figure 1 is an elevation, partly in section, of a part of a mould for making a lens from a preformed blank of plastic;

10 Figure 2 is an electric circuit diagram indicating one method of ensuring the thermostatic controls;

Figure 3 is a perspective view of one form of the complete moulding apparatus;

15 Figure 4 is a side elevation of the apparatus shown in Figure 3;

Figure 5 is a sectional elevation of part of an alternative form of mould;

20 Figure 6 is an electric circuit diagram illustrating another method of ensuring the thermostatic controls, and

Figure 7 is a complete circuit diagram for the control of the apparatus somewhat different from that in Figure 6.

25 Referring to Figure 1, 12 is a preformed blank of a transparent plastic; 13 is the lower die and 14 is the upper die (both shown with concave inner surfaces and flat outer surfaces); 15 is the lower socket here shown as a shallow socket for the die 13, and 16 is the electric heating element for the socket 15. The top socket 17 is also shown as a shallow socket for upper die 14 and it has an electric heating element 18. The surround 19 acts as a  
30 guide for the dies and it closely engages with the sides of the dies which in this case are circular in plan. The bottom cooling block 20 has upstanding guides 21 in the form of pins to enclose and guide the lower socket 15, the surround 19 (and the dies within). 22 are helical springs held in recesses in the bottom cooling block 20 and arranged to press on the under side of the socket 15 to keep it quite  
40 clearly spaced from the block 20 until the moulding pressure comes on.

The top cooling block 23 mounted on carrier 33 again has vertical guide pins 24 at intervals round the top socket 17 and in this case the pins 24 have inturned ends  
50 25 on which the top socket 17 rests until the moulding pressure comes on.

The operation is as follows:—The dies 13, 14 are carefully cleaned. The cold preformed blank 12 is carefully cleaned and laid on the lower die 13 and the upper die 14 is lowered (by hand control) until the upper die just touches the blank, the dies being in close contact with their  
55 respective sockets 15, 17 but both sockets are spaced away from the cooling blocks 20, 23. The position of the upper die may be controlled by an electrical stop such that the operator is prevented from  
60 lowering the upper block too far. Current

is turned on by hand and the sockets, dies and blank all get heated. When the dies and blanks have reached the required temperature for moulding, the current to the lower socket 15 automatically  
70 turned off by a thermo-couple and the upper socket 17 is kept at the same temperature as the lower socket by thermostat action. At the same time the moulding pressure is automatically applied thus  
75 bringing the top cooling block 23 down on to the top socket 17, bringing the lower socket 15 into contact with the bottom cooling block 20 and effecting the final moulding of the lens surfaces to their  
80 optically accurate form. At this stage the two sockets 15 and 17 are simply acting as conductors of heat from the dies 13, 14 to the blocks 20 and 23 which if desired may have conduits 26 for cooling  
85 water.

Referring to Figure 2, 27 is a thermo-couple disposed in the lower socket 15 and arranged to control a potentiometer and switch 28 on the input side of a current transformer 29 the output 30 of which is in circuit with the heating element 16. The current is cut off when the lower socket reaches a predetermined temperature.  
90 95

31 and 32 are the two thermo-couples of a differential thermostat, 31 in socket 15 and 32 in socket 17. The differential thermostat is coupled to a potentiometer and switch 38 on the input side of a current transformer 34 the output of which is in circuit with the heating element 18, which differential thermostat is arranged in known manner so as to switch the heater current on when thermo-couple 32 is at a lower temperature than thermo-couple 31 and off when thermo-couple 32 is at a higher temperature than thermo-couple 31, so that socket 17 is always kept at the same temperature as socket 15.  
100 105 110

Figure 2 does not illustrate the electric relays which control the movements of the upper block 23 but these can be operated by the thermo-couple 27 as follows:—  
115 When the lower socket 15 reaches the required temperature the thermo-couple 27, as well as cutting off the current to the heating element 16 as above described, also operates a relay which in turn operates the press so as to lower the top cooling block 23 on to the top socket 17 and apply the moulding pressure. The cooling blocks which are now in contact with the sockets commence to cool the sockets and when the lower socket 15 reaches a predetermined low temperature the thermo-couple 27 operates a second relay which in turn operates the press so as to raise the top cooling block 23 and thereby release the pressure and open the mould.  
120 125 130

The top cooling block is resiliently mounted in known manner in the movable part of a hydraulic press so that during the cooling of the dies and plastic, the dies can "follow up" any shrinkage. For example a powerful spiral spring may be interposed between the top cooling block and the movable part of the press so that any shrinkage during cooling is taken up by a slight expansion of the spiral spring without materially altering the moulding pressure.

Referring to Figures 3, 4 and 5, 40 is a base and 41 is an upright panel rigidly secured thereto. 42 is the upper part of the frame and a powerful toggle 43 in known manner is arranged to exert pressure on a cross-head 44 which is connected to the carrier 33 of the upper cooling block 23 through a powerful spiral spring 35. Pipes 45 are arranged to carry cooling water to the conduits 26 in the two cooling blocks 20 and 23 and the lower cooling block 20 is detachably mounted on a bed plate 46 at the top of the base 40. A motor 47 is coupled by gearing 47a, 47b, 47d, 47c, and bell-crank lever 43a pivoted on a spindle 43b to the toggle 43 to effect the movements of the upper cooling block 23 at the proper times. To enable the finished lens to be ejected from the apparatus, the handle 48 is pivoted in the base 40 and is operatively connected to the vertical ejection rod 49 shown in Figures 4 and 5.

Referring to Figure 5, the upper cooling block 23 mounted on the carrier 33 has in this case a central socket 50 housing a spiral spring 51 which engages with the top of the upper socket 17 which is guided by three pins 24 having heads 25. The upper socket 17 has an electric heater 18. The bed plate 46 carries the lower cooling block 20 which in this case has a central socket 52 housing a spiral spring 53 which surrounds the ejection rod 49 and presses against the lower surface of the lower socket 15 which is guided by three pins 21 having adjustable heads 54. The lower socket 15 has an electric heater 16 and thermo-couple 27. In the arrangement shown in Figure 5 the surround 19 is screwed into the lower socket 15. The mechanical operation of the arrangement shown in Figure 5 is the same as that of the arrangement shown in Figure 1.

Referring to Figure 6, it should in the first place be understood that the general object of the electric equipment is to operate the press electrically and also to energise the heating circuit at the proper times, and incidentally to prevent movement of the press when it is not desired. The various elements in the diagram of Figure 6 are merely formal and the dia-

gram will be best understood by a description of the operation:—

On the panel 41 there is a three-way switch 55 with three positions "Automatic," "Off" and "Manual."

When the prepared blank 12 is placed between the upper and lower dies 14, 13, the switch 55 is turned to the position marked "Manual." The two push-buttons 56 and 57 on Figure 3 control manually the "up" stroke and "down" stroke of the upper die, and the upper die is brought down into contact with the blank which is lying on the lower die. At this stage the lower and upper sockets 15, 17 are not in contact with the cooling blocks 20 and 23. When the upper die 14 lightly touches the blank 12 the fact is indicated by a slight movement of the socket 17 away from the abutments 25. A very slight pressure amounting to only a few pounds is thus applied to the blank 12 by the cold dies 13 and 14. The starter button 61 is now operated and then the control switch 55 is changed over to "Automatic." The pressing of the starting button 61 closes the push-button switch 61a and thereby closes the circuit of an electric relay 62 which switches on the heating current to the heaters 16 and 18. The operation of the relay 62 closes the terminals 62a and thereby closes the circuit of the primary of a transformer 63 the secondary of which supplies current to both the bottom and top heating units 16, 18. It is to be noted that the voltage used is adjusted for the size of die to be used. For dies of 2" diameter or less, 20 volts is suitable and about 400 watts per heater is used. For dies of 2" to 4" diameter, 30 volts and 600 watts per heater is most suitable. Another effect of operating the relay 62 is to break the circuit at 66 of the relay 67 which controls the up-stroke of the upper die. The press then remains in this position with the die 14 lightly touching the blank 12 until the thermo-couple 27 placed in the lower socket 15 registers the correct moulding temperature, whereupon the couple operates terminals 70, 71 and 72 through the relay 73, whereby a holding circuit for relay 73 is established through terminal 70, the circuit through relay 62 is broken at terminals 72 and terminal 71 starts the time switch. Relay 62 being de-energised, switches off the main heating current, but a shunt 75 is provided in the form of a resistance in a subsidiary circuit through the primary of transformer 63 and terminals 99 of relay 76 which are closed when relay 76 is de-energised, which shunt maintains a subsidiary heating current which keeps the dies at a temperature substantially equal to the

temperature to which they have been already brought for a time which is set on the time switch 74. At the end of this time the time switch 74 operates relay 100 thereby closing terminals 101 and completing the circuit of the relay coil 76, relay 80 being de-energised at this time and therefore terminals 79 being closed. Relay 76 closes at terminals 103 the circuit of the coil 68 which operates the down-stroke of the press, and also switches off at terminals 99 the shunt 75 thus stopping the heating. The sockets 15 and 17 are then pressed firmly against the cooling blocks 20 and 23, and the full moulding pressure is then applied to the blank 12. This pressure may be two tons per square inch for methyl methacrylate polymer or one ton per square inch for polystyrene. The press then remains in this position until the thermo-couple 27 registers the correct temperature for removal of the lens. The thermo-couple then operates relay 80 and the terminals 77, 78, 79, thereby breaking at 79 the circuit through relay 76 which in turn breaks at 103 the circuit through coil 68. Relay 80 also completes at 78 the circuit through coil 67 and thus effects the up-stroke of the press and the cycle is completed.

Referring to Figure 7, the pressing of button 61 closes the push-button switch 61a and thereby closes the circuit of an electric relay 62, this circuit passing through terminals 72 of relay 73, these terminals being closed at the time, relay coil 73 not being energised. The power connection for the circuit is indicated at 61b. The energising of relay 62 closes the circuit of the primary of a transformer 63 the secondary of which supplies current to both the bottom and top heating units 16 and 18 of the socket members 15 and 17. The primary circuit of this transformer passes through terminals 62a of relay 62 which are closed when this relay is energised and is connected to the power mains as indicated at 62b. The voltage used for the heating circuit should be adjusted for the size of dies which are to be used. For dies of 2 inch to 4 inch diameter, 30 volts and 600 watts per heater is suitable.

Another effect of operating relay 62 is to break the circuit of relay 67 which controls the up-stroke of the upper die as will be described hereinafter. This circuit extends from the power mains connection 62b and passes through the terminals 66 of relay 62 which are closed while the relay coil 62 is de-energised and are accordingly opened by its energisation, this circuit also passing through the terminals 78 of relay 80 which are closed

when this relay is energised as it is at this time. Relay 80, it may here be remarked (although shown de-energised) was energised on the preceding operation when the dies, socket members, and blank had cooled and the blank set sufficiently for the blank to be removed, and it remains energised until the temperature of the socket members rises above this temperature. At the beginning of the following operation here described, the socket members are still below the temperature at which relay 80 will be de-energised and therefore placing the press on automatic operation would result in raising the press, if it were not for the opening of the circuit of relay 67 at 66 as just described. The result of this is that the upper die is prevented from moving upwardly from its position of light contact with the blank until relay 67 is again energised.

The press control circuit may be referred to briefly at this point. The up-stroke relay 67 in the specific embodiment of the invention illustrated, operates a three-phase contactor 81 which causes the motor 47 to rotate in an anti-clockwise direction, thus causing the cross-head 44 and connected movable parts of the press to move upwards by means of the gear and rack and pinion connections 47a, 47b, 47c, 47d described. This upward movement continues until the bar 82 mounted to rotate with pinion 47b strikes the limit switch 84, thus breaking the circuit of the coil 67 and stopping further movement of the press. The down-stroke coil 68 correspondingly operates the contactor 81 in a clockwise direction and causes the press to down-stroke; this movement is limited by the striking of bar 82 against the limit switch 83.

The press remains in its described position in which the blank is lightly contacted by the two dies until the socket members 15 and 17 have been heated up to a predetermined temperature as registered by the thermo-couple 27 which is placed in the lower socket member 15 as previously described. The result of this is to energise the relay 73 and thereby to de-energise relay 62 as will now be described.

The thermo-couple 27 is connected to two potentiometer circuits, namely by connections 85, to terminals 86 on the casing of the potentiometer 87 and by connections 85, 88 to the terminals 89 on the said casing, the two circuits referred to connected respectively with the terminals 86 and 89 being inside the said casing and not shown. The apparatus referred to is well known and its details accordingly are not described or illustrated. The first potentiometer circuit 130

connected with terminals 86 energises the relay 73 when the temperature rises above the reading set on the dial 90 of the first potentiometer, the circuit then being closed by a switch in the potentiometer mechanism, through terminals 91, 92 of the potentiometer to the coil 73. Terminals 70 of coil 73 are thereby closed to establish a holding circuit through coil 73 and terminals 93, 92 and 91 of the potentiometer to maintain the coil 73 in energised condition. Relay 73 will be de-energised when the temperature determined by thermo-couple 27 falls below the reading set on the dial 90. Energy for the potentiometer circuits is taken off the mains as indicated at 94.

The second potentiometer circuit energises relay 80 in similar fashion when the temperature in socket member 15 falls below the reading on dial 95 when the moulded lens has set sufficiently to be removed from the press. In this case the circuit for energising relay coil 80 is completed through terminals 96, 97 of the second potentiometer, a holding circuit for this coil then being established through terminal 98 of the potentiometer and the terminals 77 of coil 80. Relay 80 will be de-energised by the potentiometer when the temperature in the socket members rises above the reading set on dial 95.

When relay 73 is energised relay 62 is de-energised as stated above, its circuit being broken by the opening of terminals 72 of relay 73 consequent upon the energising of this relay. Terminals 71 of relay 73 are closed at the same time which completes the circuit for time switch 74 to the power connection 62b. The de-energising of relay 62 breaks the circuit of the primary of transformer 63 by the opening of terminals 62a of relay 62 but a new energising circuit for this transformer primary is immediately established through a shunt 75 across the terminals 62a, this shunt extending through the terminals 99 of relay 76, these terminals being closed while relay 76 is de-energised. Accordingly heating current for heating coils 16 and 18 in socket members 15 and 17 will continue to be supplied from the secondary of transformer 63 at a constant rate for a time which is set on the time switch 74. The object of this provision is to provide heat to the socket members for a determined length of time after socket member 15 has attained the temperature set on dial 90 so that the blank 12 whose temperature rise lags slightly behind that of the socket members shall attain the predetermined moulding temperature.

At the end of the time set on the time

switch 74 the latter closes a circuit which energises relay coil 100 thereby closing the terminals 101 of this coil which, as shown, remain open so long as this coil remains de-energised. The time switch is a well-known mechanism and therefore is only indicated conventionally. The closing of terminals 101 completes the circuit of the relay coil 76, this circuit passing through terminals 79 of relay 80 which are closed, relay 80 being de-energised. Energy for this circuit is supplied from the connection to mains 102. The energising of coil 76 opens the terminals 99 of this coil and thereby opens the shunt circuit 75 by which the primary of transformer 63 was supplied so that the supply of heat to coils 16, 18 in the socket members is cut off. The operation of relay 76 by closing its terminals 103 also closes the circuit of relay 68 which operates the down-stroke of the press, as previously described. The cooling blocks 23 and 20 are thereby pressed firmly against the socket members 17 and 15 and the full moulding pressure is then applied to the blank 12 through the intermediary of the cooling blocks, socket members and dies.

The press then remains in this position until the moulded lens has cooled and set to the predetermined temperature at which it can be removed. At this time the thermo-couple 27 operates relay 80 as previously described. This opens the terminals 79 of this relay and thereby de-energises relay 76 so that the circuit for the down-stroke relay 68 is broken. The operation of relay 80 also closes its terminals 78 and thereby switches on the circuit of up-stroke relay 67 which circuit is completed through terminals 66 of relay 62 which latter relay was de-energised by the operation of relay 73 at the time when the temperature of the socket members rose above the reading set on dial 90 as previously explained. The press therefore moves upward to its uppermost position, determined by up-stroke limit switch 84. The de-energising of relay 76 also by closing its terminals 99 again connects the shunt 75 across the terminals 62a and the press, after the removal of the finished moulded lens, is ready for another operation.

It will be observed that the described apparatus permits the practising of a method whereby the blank is heated, between opposing dies, to moulding temperature whereupon the supply of heat is cut off and simultaneously moulding pressure is applied and cooling of the blank is instituted, the pressure and cooling being continued until the moulding is complete and the finished article has set. For this operation it is necessary to calcu-

late and provide such a rate of cooling that the moulding will be completed before the article sets. This can readily be done by providing for abstraction of heat from the socket members by cooling blocks and dissipation thereof at a suitable rate as by means of a suitably calculated cooling water system therefor.

In patent specification No. 556,743 an apparatus is described and illustrated wherein the actual movement of the moving parts is effected by hydraulic or pneumatic means.

The present invention is applicable to a moulding press having hydraulic or pneumatic action, but even so, the control and the timing are effected electrically by thermo-couples and by electric switches as indicated above.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. A method of moulding plastic articles particularly optical elements such as lenses from blanks of transparent thermoplastic material in which a cold pre-formed blank is inserted between opposed dies which are brought gently into contact with the blank and electric current is switched on after which the operations of heating the blank to moulding temperature, applying moulding pressure, cooling the dies and the moulded article, release of pressure and opening of the mould are effected automatically by electric means.

2. A method as claimed in claim 1 in which the maintenance of pressure on the dies during cooling and the equalising of the temperature of the two dies are also effected automatically.

3. A method as claimed in claim 1 in which the heating of the pre-formed blank is effected through dies mounted in metallic sockets embodying electric heating elements, and the cooling of the moulded article is effected through the dies coming in contact with adjacent cooling blocks, the position and movement of the sockets being such that during the heating stage they are spaced away from the adjacent cooling blocks while during the cooling stage the sockets are brought into contact with the adjacent cooling blocks.

4. A method as claimed in any of the preceding claims in which electric current is switched on to the heating elements of the sockets when the dies are both in contact with the blank and thereafter application of pressure, the switching off of the heating current and the release of pressure are effected by thermostat control.

5. An apparatus for moulding plastic articles, particularly optical elements such

as lenses from blanks of transparent thermoplastic material, comprising two opposed dies the operative faces of which are optically accurate matrices, which dies are a sliding fit in a metal surround, shallow sockets embracing the dies and each provided with an electric heating element, the outer face of each socket being normally spaced away (by springs) from cooling blocks, automatic means for controlling the electric heating elements and for switching off the heating current when the blank has reached moulding temperature, automatic means for applying pressure to the dies and sockets to effect the moulding and for bringing the sockets into contact with the cooling blocks after moulding temperature has been reached and automatic means for releasing the pressure after moulding.

6. An apparatus as claimed in claim 5 comprising a press framework, a fixed base in said framework carrying a lower cooling block, a carrier movable in the frame and holding the upper cooling block, sockets guided in relation to the cooling blocks and normally spaced away therefrom by springs, dies with optically-accurate faces housed in said sockets, electric heaters in the sockets, cooling conduits in the cooling blocks and automatic means for (a) controlling the heating current, (b) applying moulding pressure to the sockets and dies and to a blank between the dies, and (c) bringing the cooling blocks into contact with the sockets and automatic means for relieving said pressure and raising the upper cooling block, socket and die.

7. An apparatus as claimed in claim 6 in which the lower die is provided with an ejection device for raising the lower die in the lower socket.

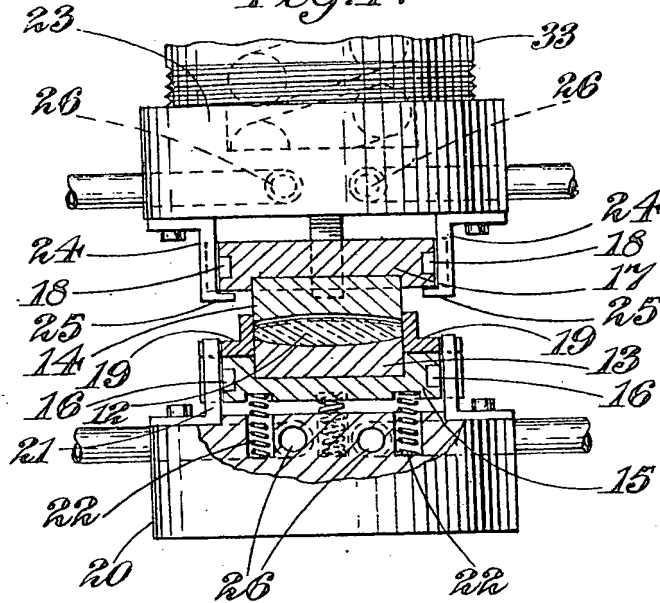
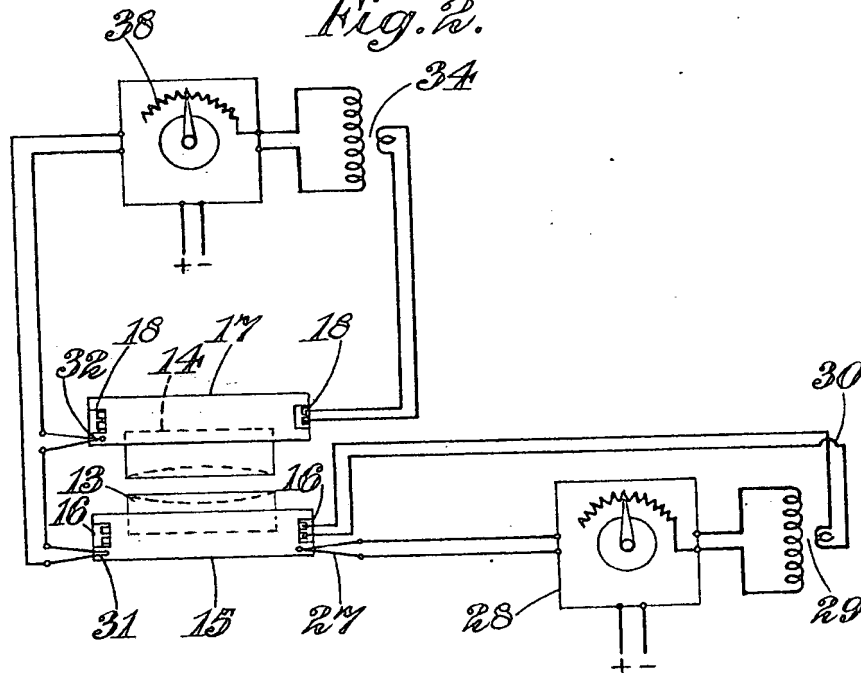
8. An apparatus as claimed in any of the preceding claims 5, 6 or 7 in which the electric heaters in the sockets are controlled by one or more thermostats in said sockets and in which the same thermostat or thermostats electrically control the timing of the application and the release of pressure.

9. An apparatus as claimed in any one of claims 5 to 8 in which the opposed dies are embraced by a surround which determines with precision the periphery of the moulded article.

10. An apparatus as claimed in any one of the preceding claims 5 to 9 in which the movement of the upper die, socket and cooling block are effected by a toggle mechanism actuated by an electric motor.

Dated this 26th day of October, 1944.

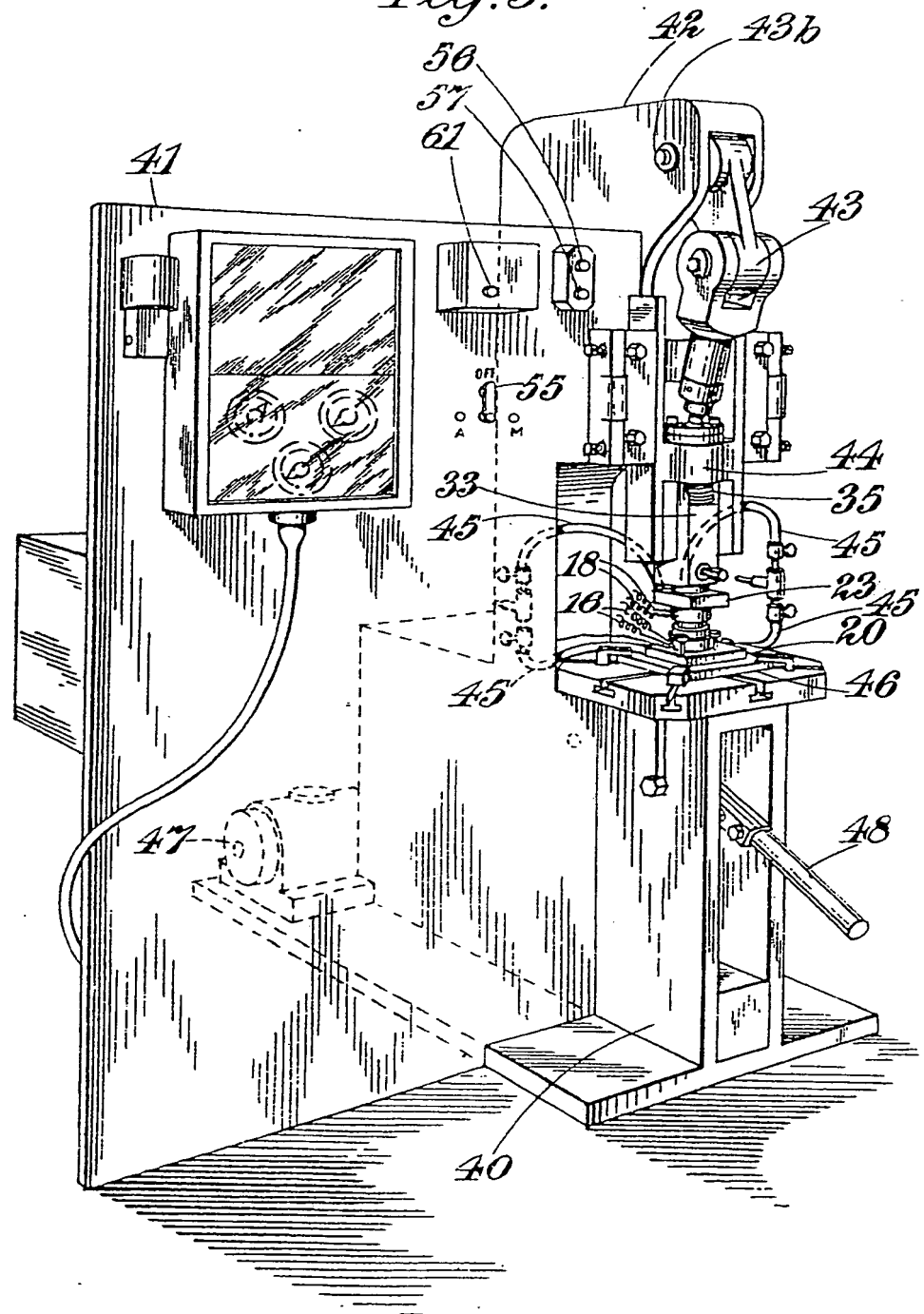
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London, E.C.1,  
Chartered Patent Agents.

2<sup>nd</sup> Edition*Fig. 1.**Fig. 2.*

H.M.S.O. (Ty.P.)

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 3.



[This Drawing is a reproduction of the Original on a reduced scale.]

43b

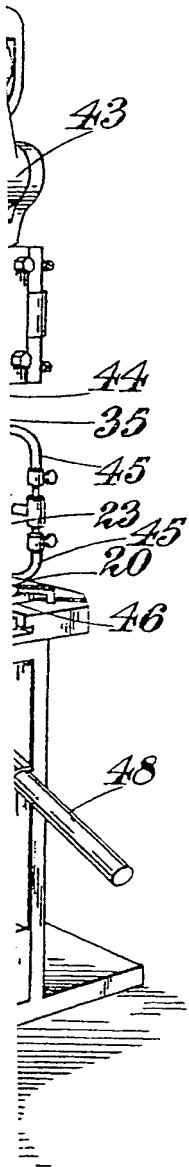


Fig. 4.

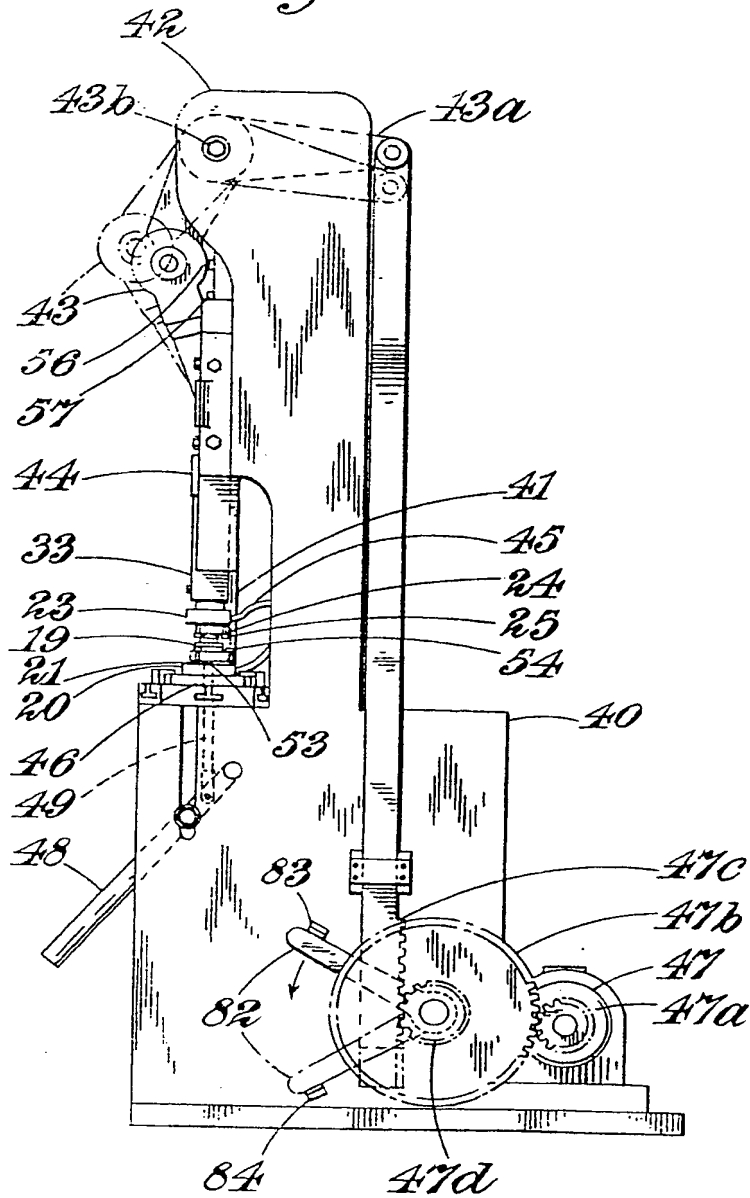


Fig. 3.

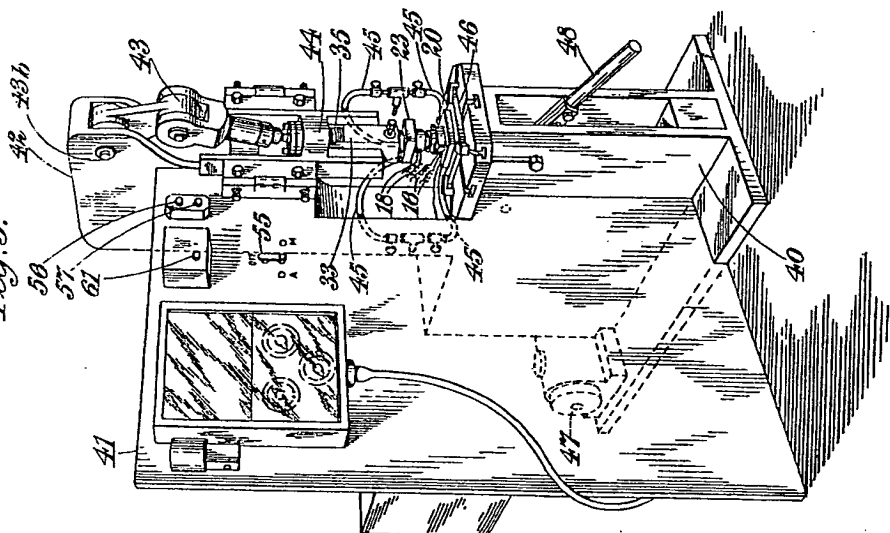
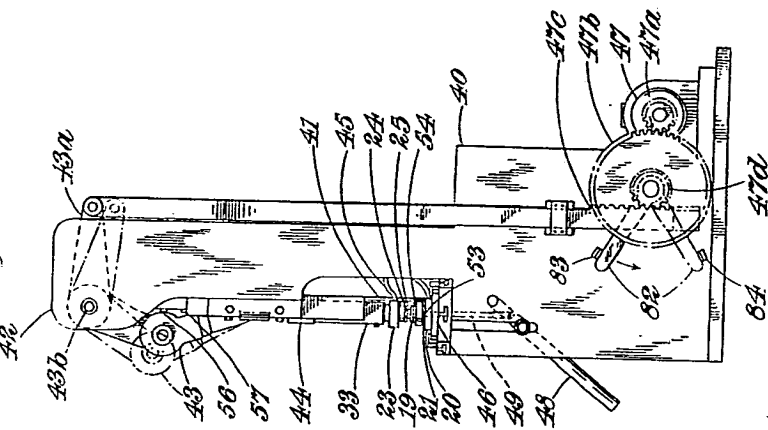


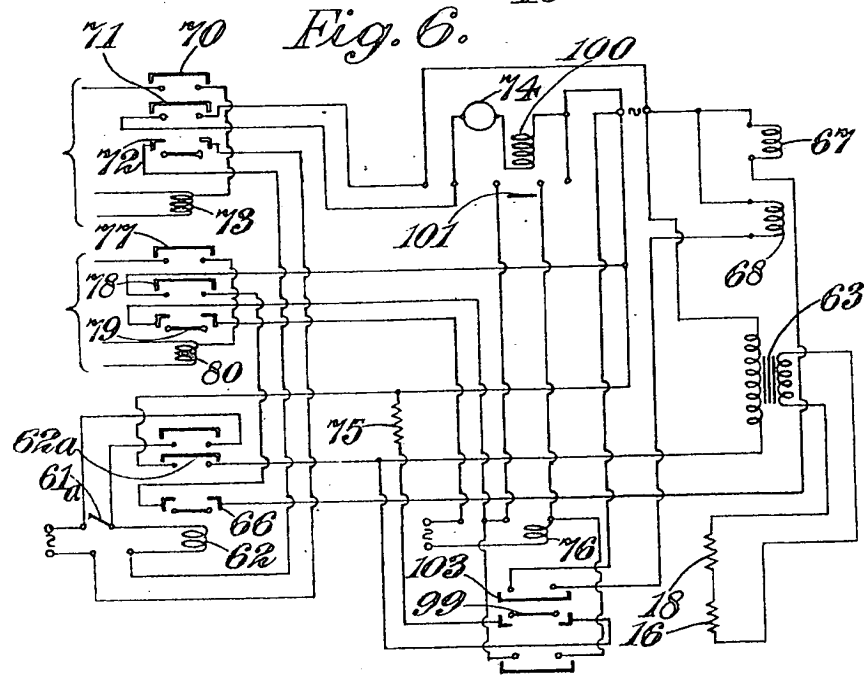
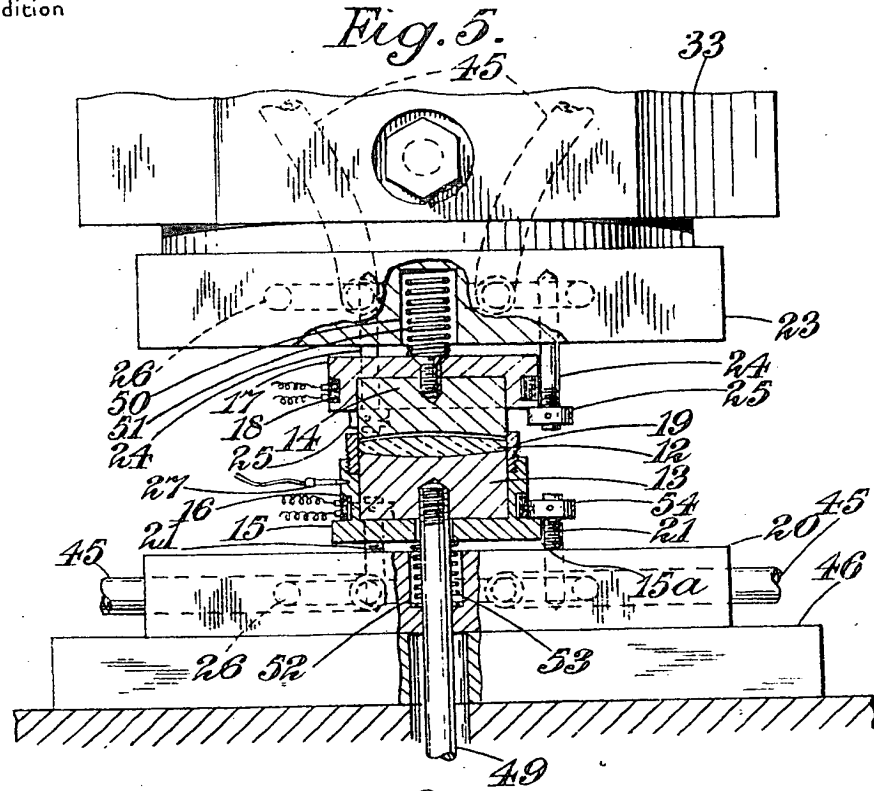
Fig. 4.



[This Drawing is a reproduction of the Original on a reduced scale]

2nd Edition

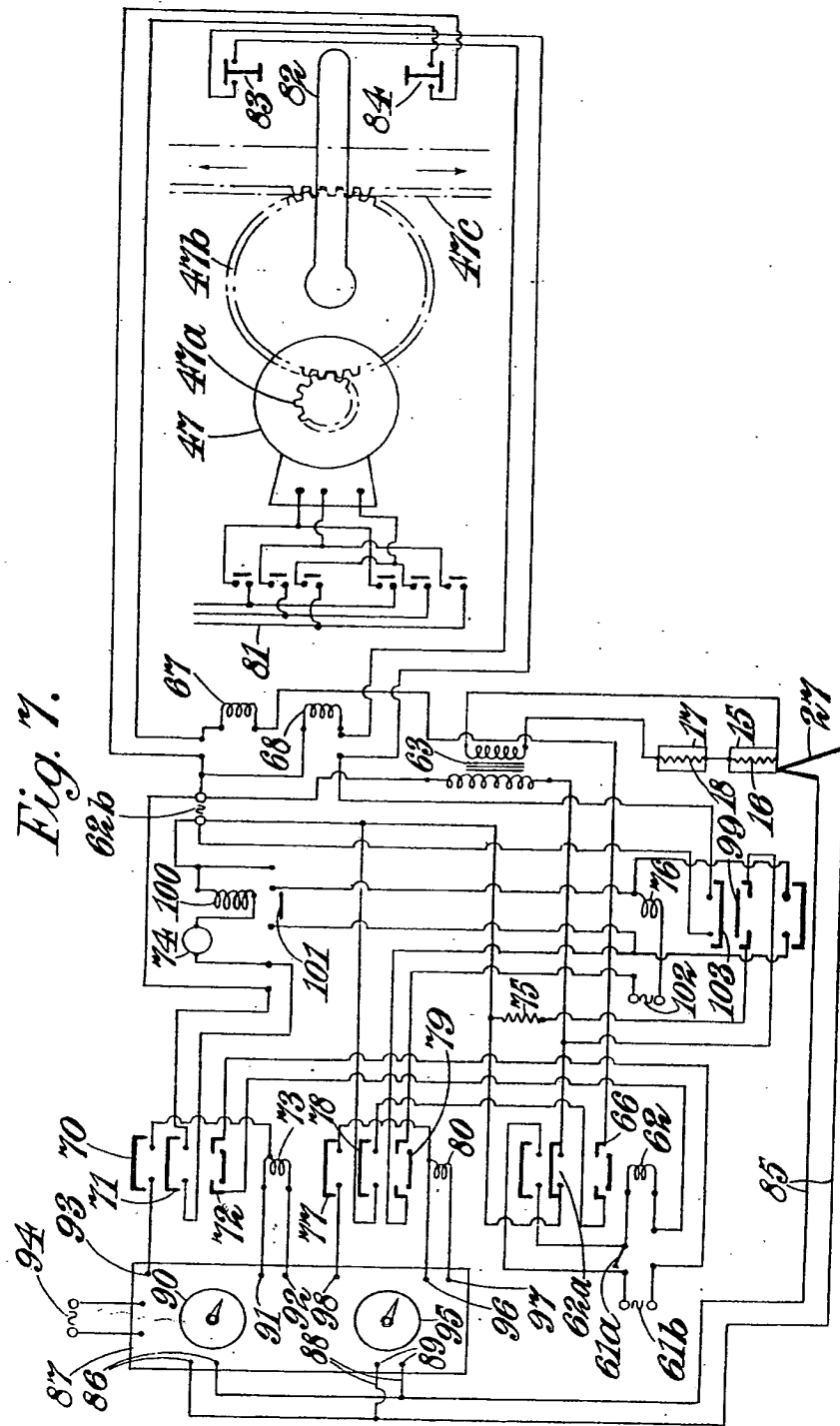
[This Drawing is a reproduction of the Original on a reduced scale.]



H.M.S.O. (Ty.P.)

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 7.



H.M.S.O. (Ty.P.)

